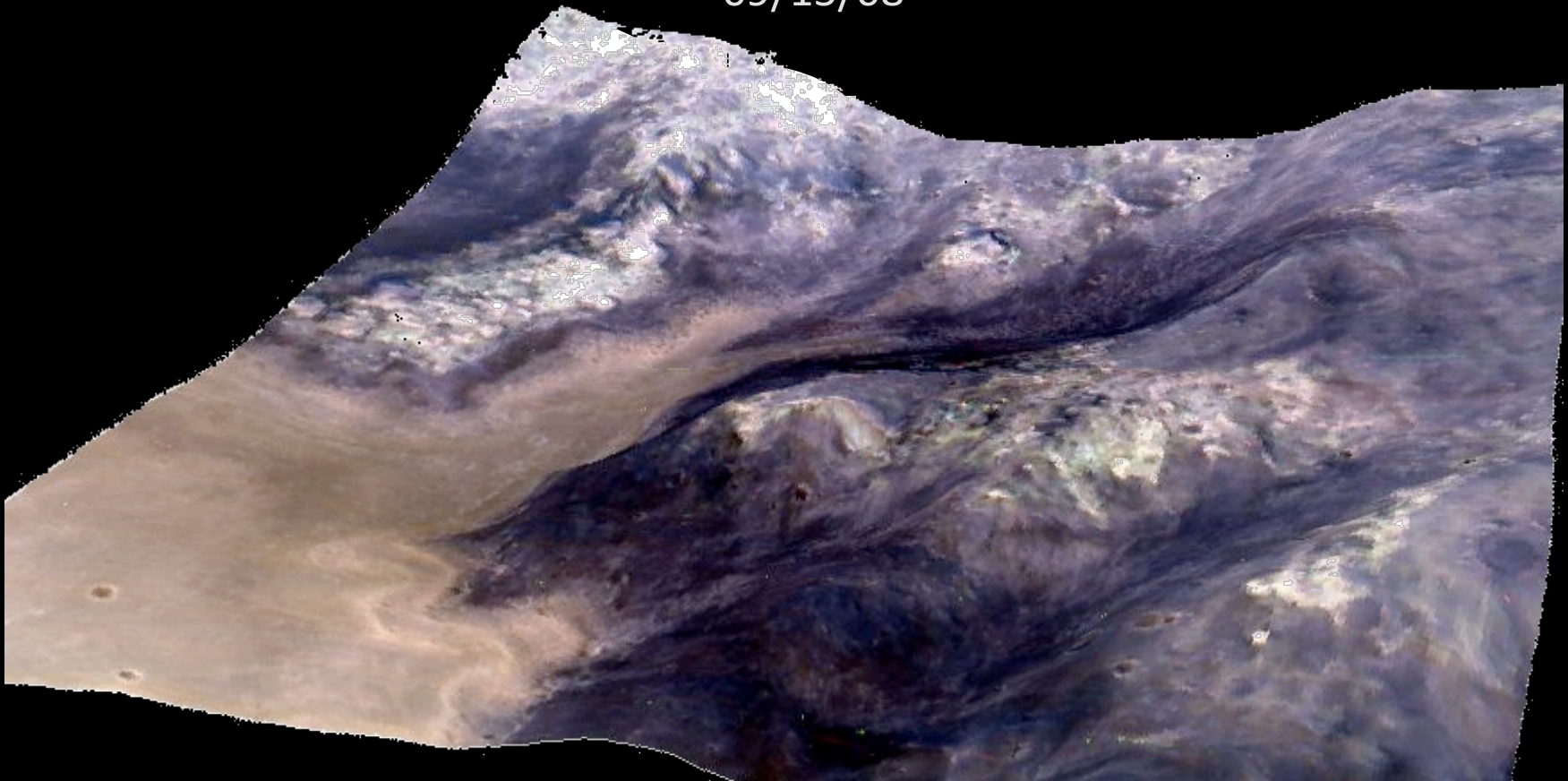


Southern Meridiani Phyllosilicate / Sulfate + Hematite Contact

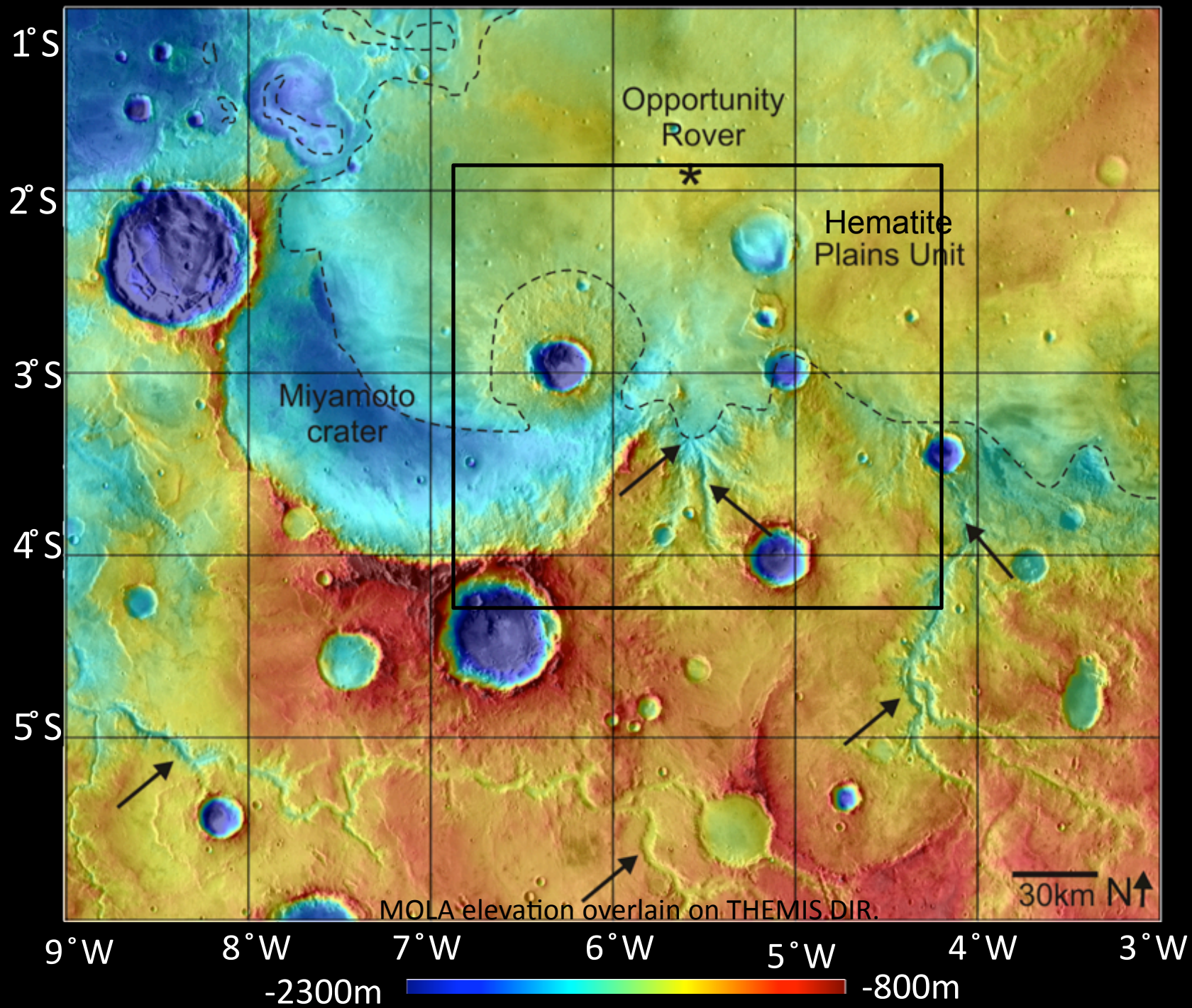
R. E. Arvidson, S. M. Wiseman, and The CRISM Team

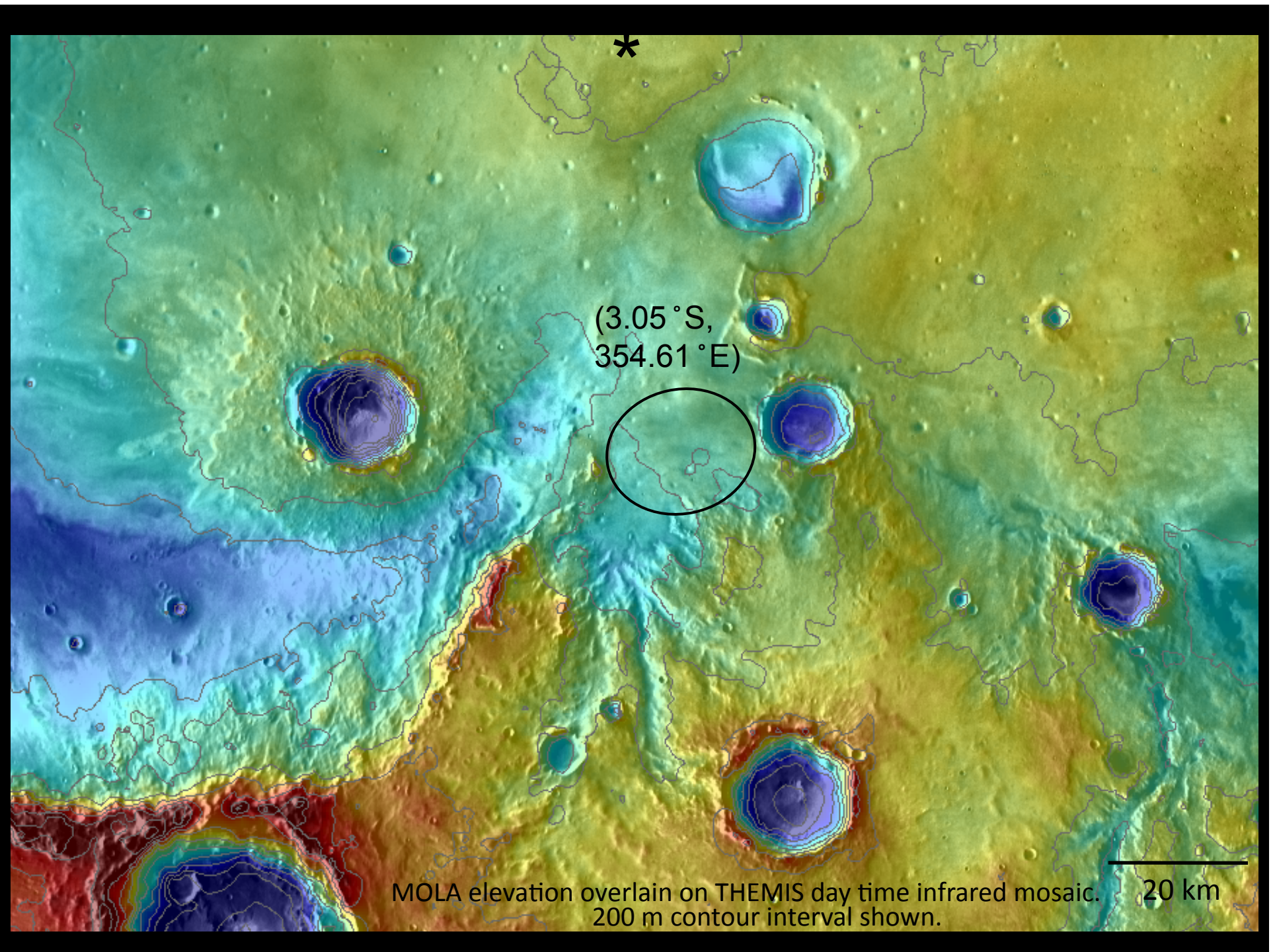
09/15/08



Phyllosilicate / Sulfate + Hematite Contact

- In place Noachian phyllosilicate exposures → diverse mineral assemblage
 - In place alteration of Noachian crust?
 - Sedimentary deposits?
 - Impact related?
- Middle to late Noachian fluvial dissection
 - Geomorphic evidence for widespread fluvial activity during the middle to late Noachian period
 - Fluvial dissection of phyllosilicate-bearing materials
- Noachian / Hesperian contact
 - Sulfate and hematite rich plains unit analyzed by the Opportunity rover 75 km to the north embays phyllosilicate-bearing terrain
 - Sample different more basal stratigraphic level in sulfate-hematite unit → synergy with MER Opportunity

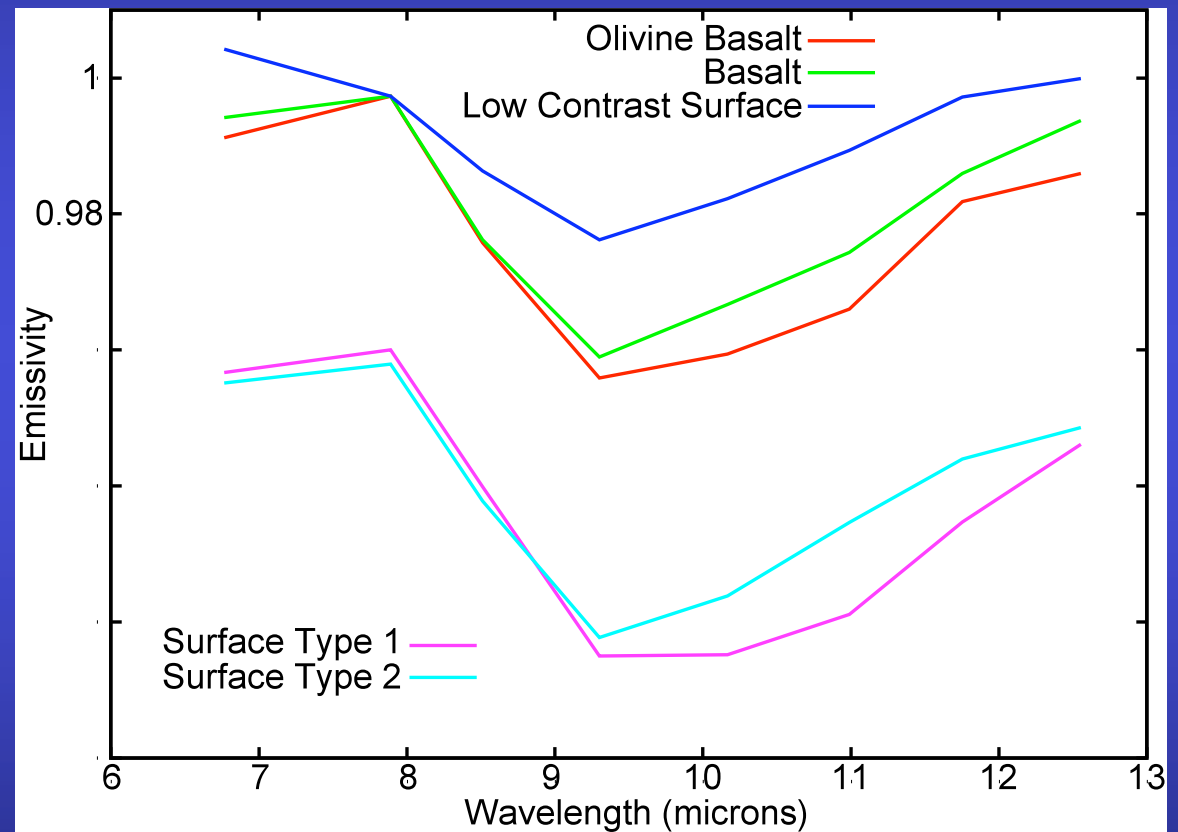




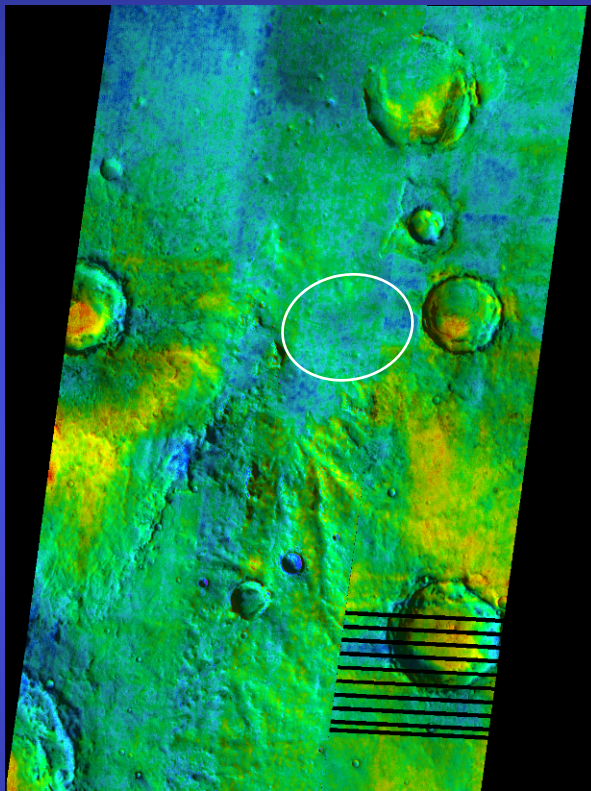
THEMIS CDP Analysis

South Meridiani THEMIS spectral endmembers

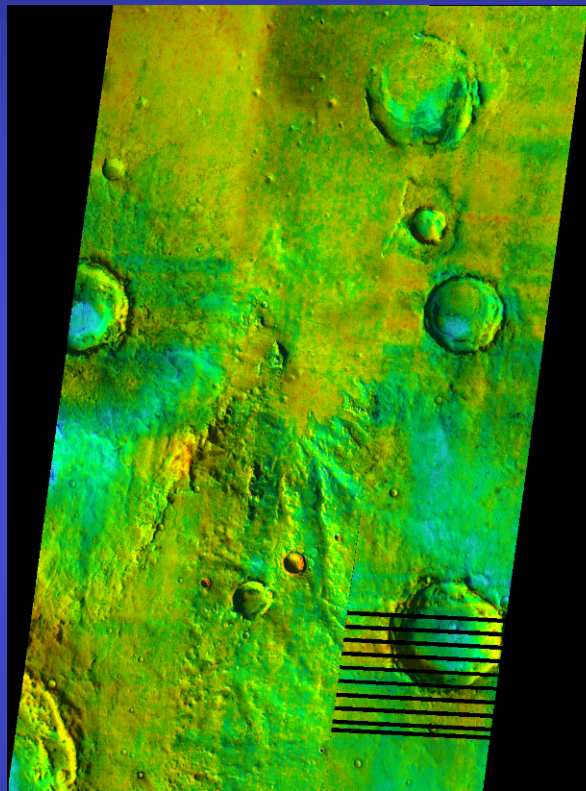
- Two slightly different basaltic composition units are present in the data
 - The two units are combined in the unit maps because they are not cleanly separated
- Low-contrast surfaces may be due to high hematite concentrations, variable surface textures, or slight dust contributions



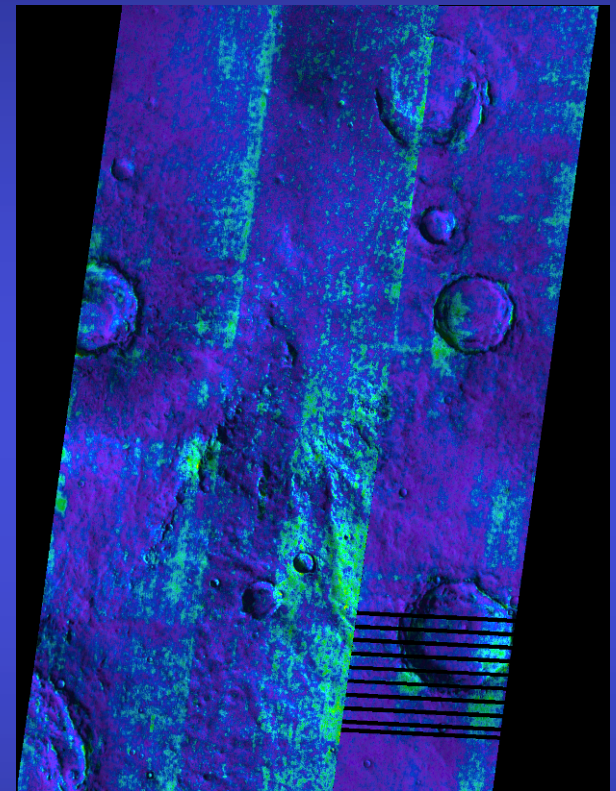
THEMIS spectral unit mosaics



Olivine Basalt
(0-2)



Blackbody
(-1 1)



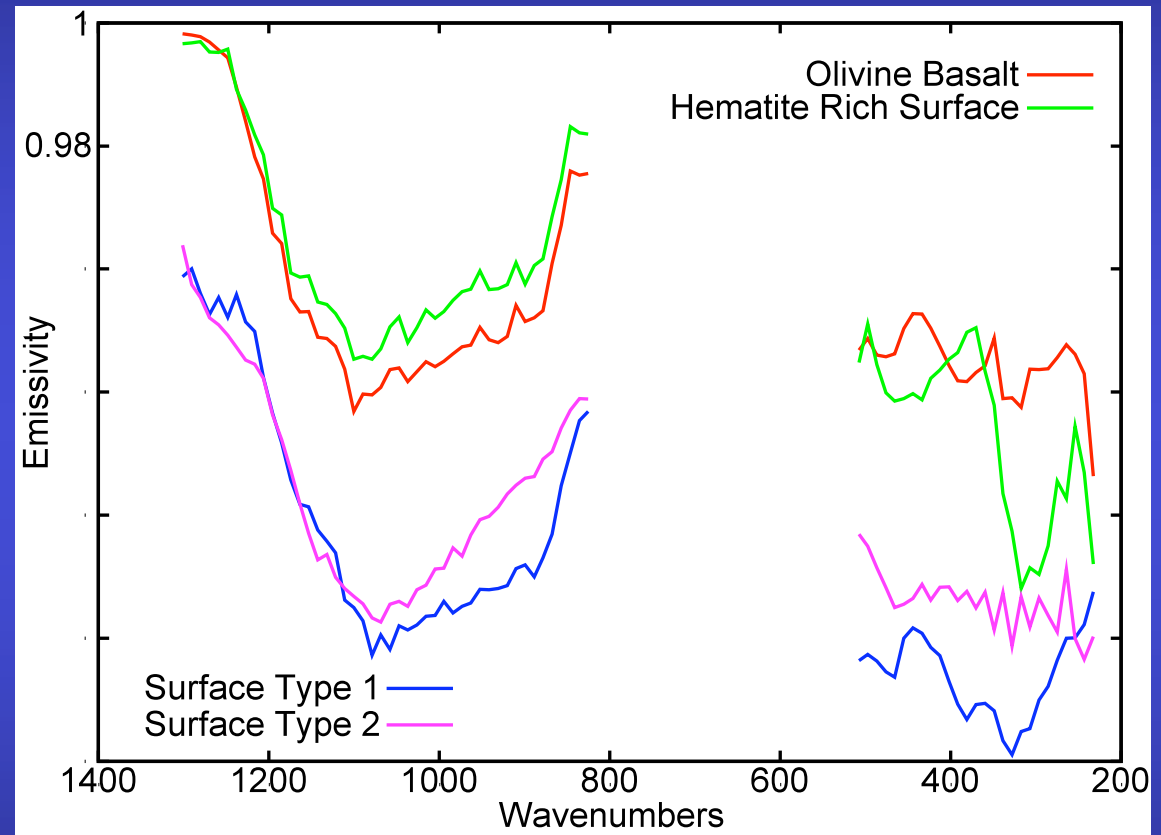
RMS Error
(0-0.005)



South Meridiani

TES analysis of THEMIS spectral units

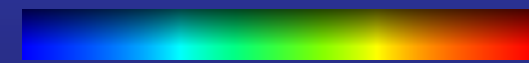
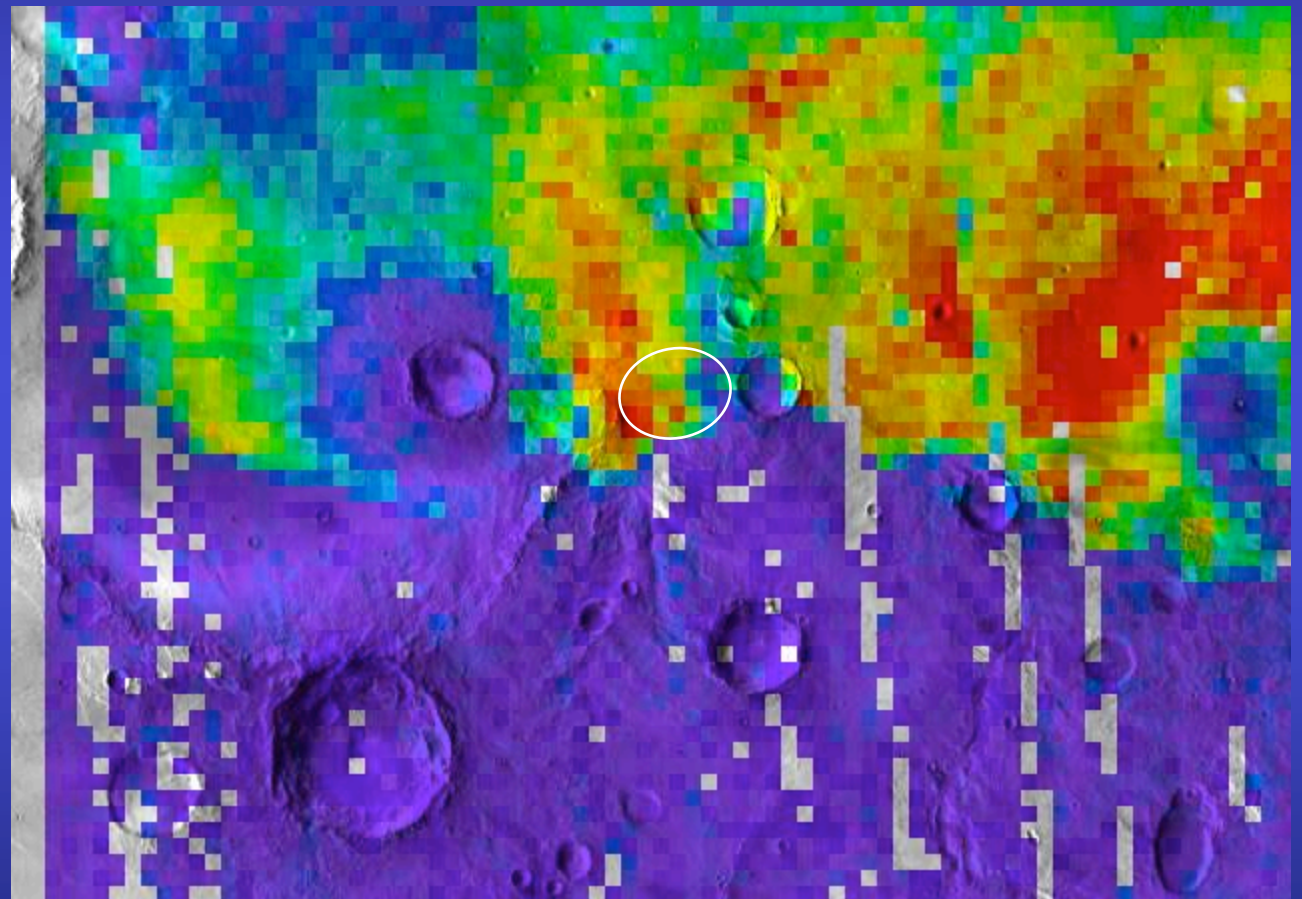
- All surfaces have significant plagioclase and pyroxene (~20-40%)
- Olivine, sulfates, high-silica phases are present at lower levels
 - Consistent with slight aqueous alteration?
 - Sulfate detection is questionable, but not unreasonable
 - Landing ellipse is spectrally similar to MER Meridiani



South Meridiani

Hematite Concentrations

- Significant hematite concentrations are present within the landing ellipse



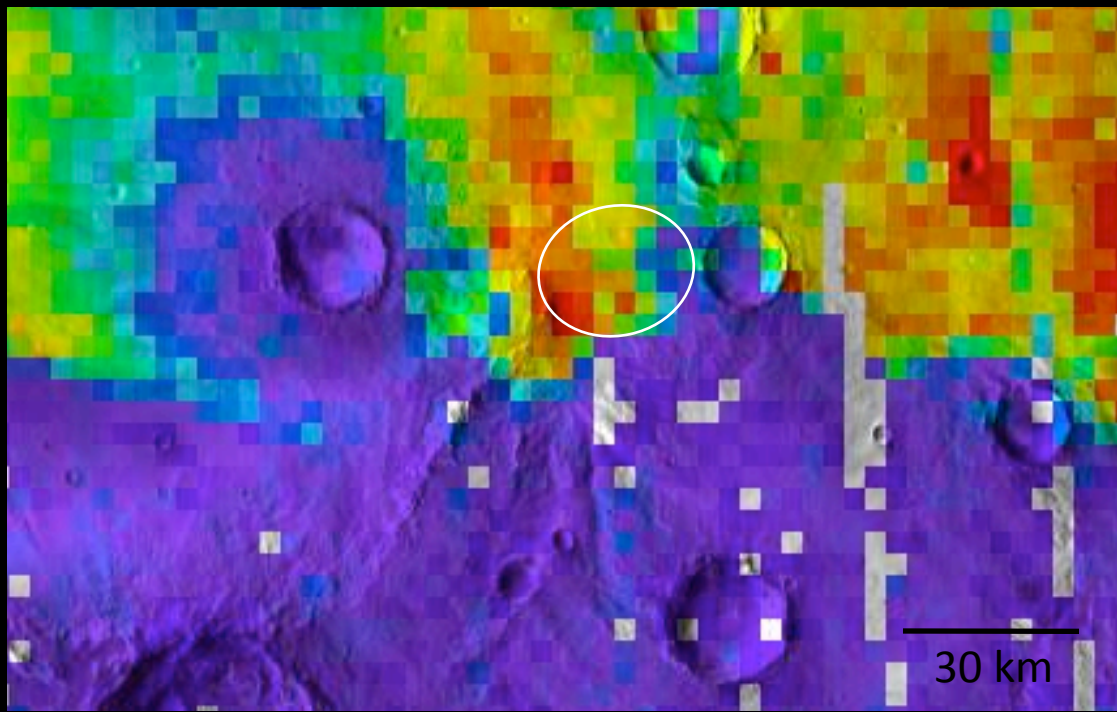
0

0.5

Concentration
(relative to strongest signal)

Summary

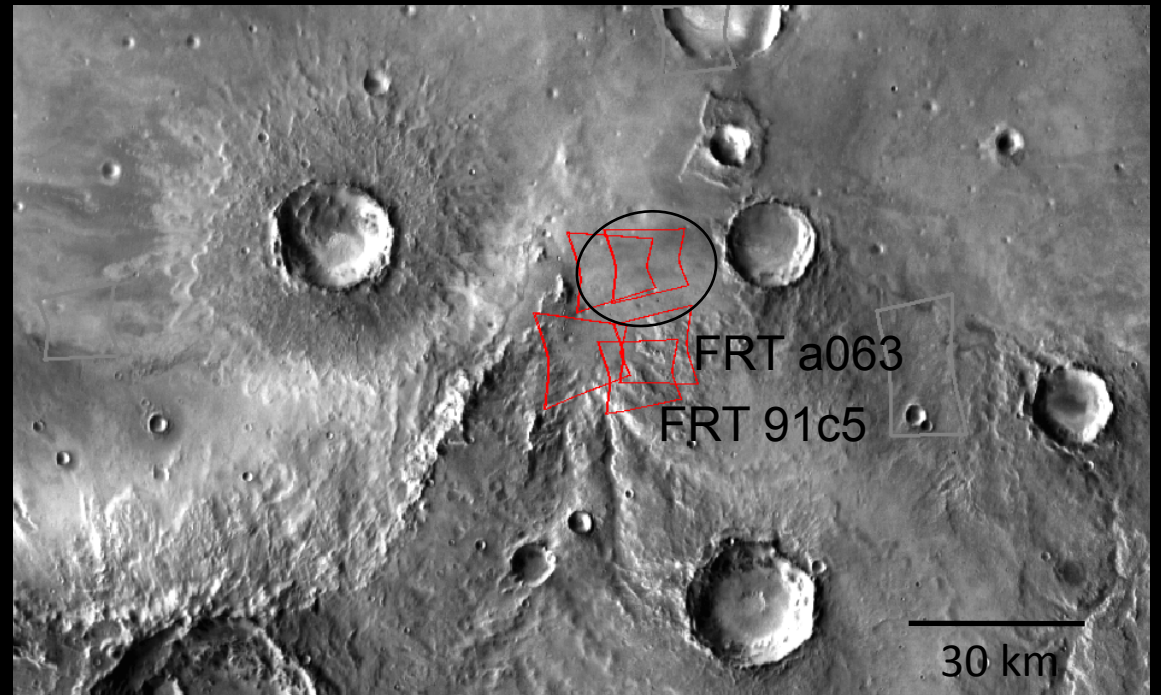
- Two slightly different units with compositions similar to basalt may be present within the South Meridiani landing site region
 - Differences between units is subtle and not well separated in THEMIS and TES data
 - Some amount of aqueous alteration is likely even in regions without hematite
- Significant hematite concentrations are located within the landing ellipse
- Dust is not significant throughout most of the region



TES hematite map on a
THEMIS day time infrared
mosaic [Bandfield and
Rogers]

0 Concentration 0.5
(relative to strongest signal)

THEMIS day time infrared
mosaic with CRISM high
resolution footprints
overlain (also have HiRISE
and CTX coverage)

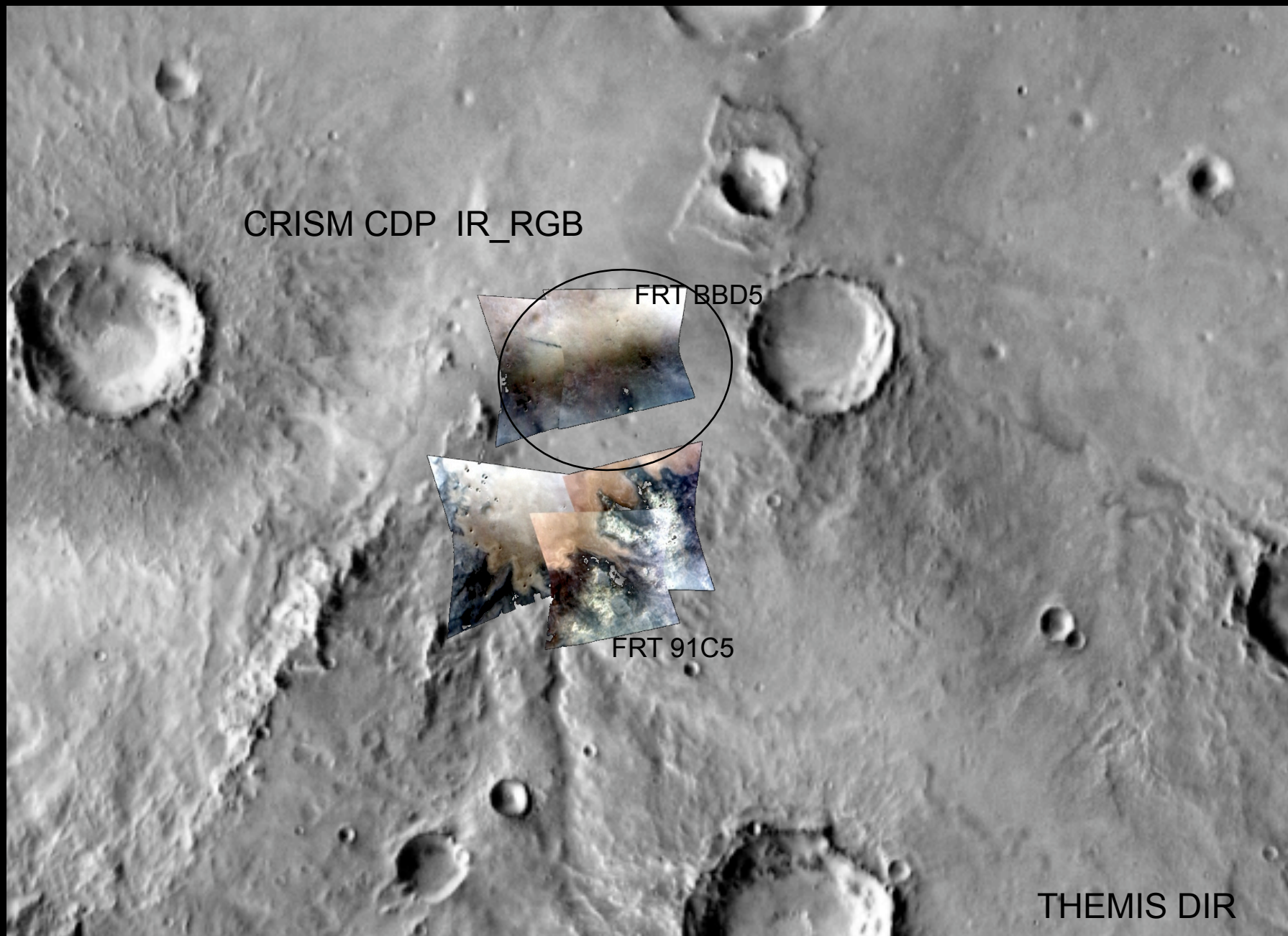


CRISM CDP IR_RGB

FRT BBD5

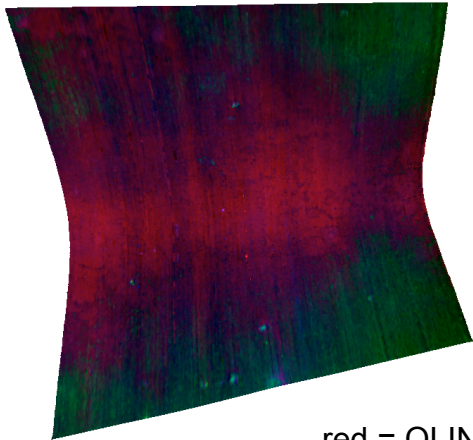
FRT 91C5

THEMIS DIR

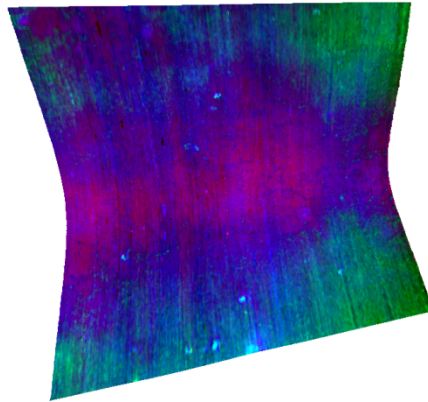


CRISM CDP Products (F. P. Seelos and O. S. Barnouin-Jha)

FRT BBD5 IR_MAF
regional stretch

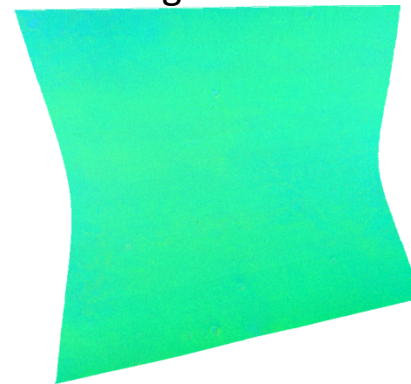


FRT BBD5 IR_MAF
site stretch

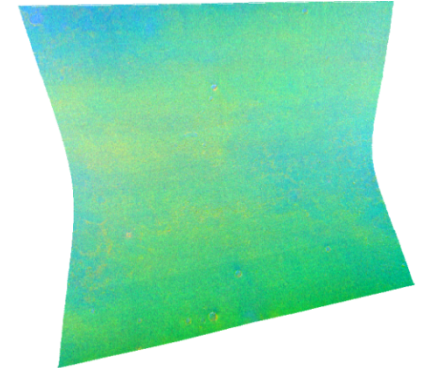


red = OLINDEX (olivine)
green = LCPINDEX (low-Ca pyroxene)
blue = HCPINDEX (high-Ca pyroxene)

FRT BBD5 VNIR_FEM
regional stretch

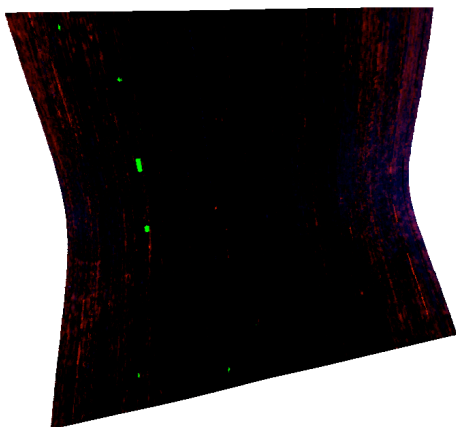


FRT BBD5 VNIR_FEM
site stretch

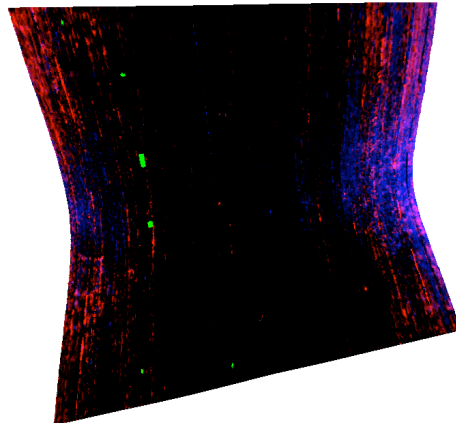


red = BD530 (ferric minerals)
green = SH600 nm (coatings)
blue = BDI1000nm (variety of iron minerals)

FRT BBD5 IR_HYD
regional stretch

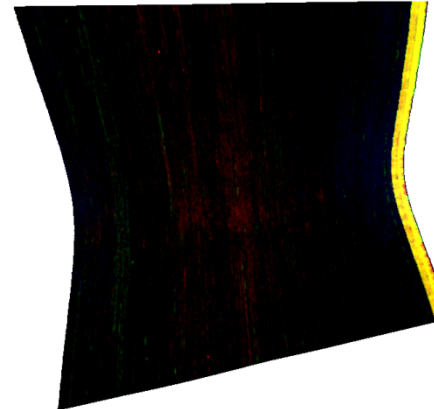


FRT BBD5 IR_HYD
site stretch

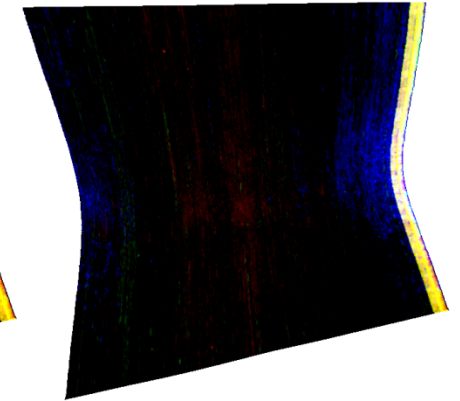


red = SINDEX (water-containing minerals)
green = BD2100 nm (monohydrated sulfates)
blue = BD1900nm. (hydrated sulfates, clays, or glass)

FRT BBD5 IR_PHY
regional stretch



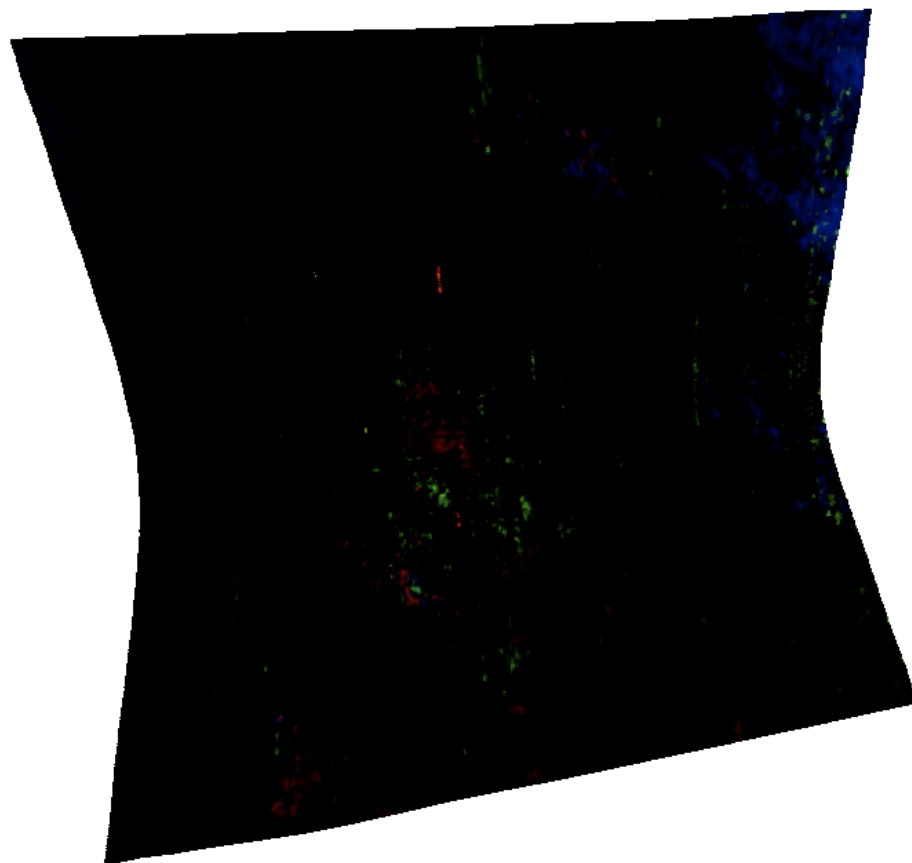
FRT BBD5 IR_PHY
site stretch



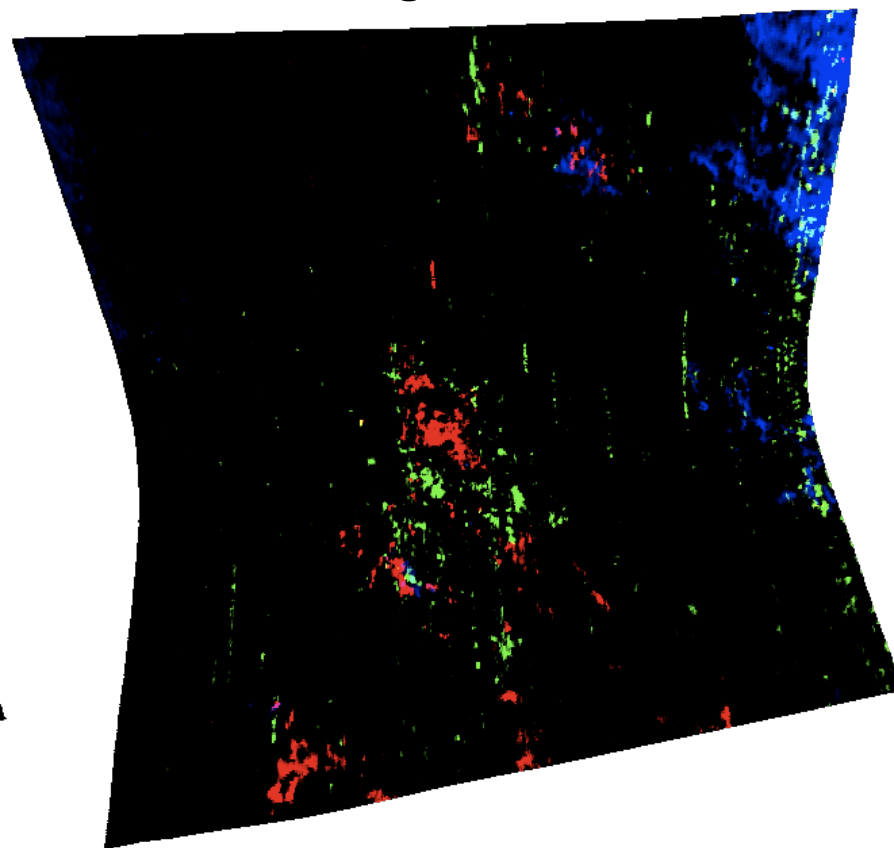
red = BD2300 (Fe/Mg phyllosilicate)
green = BD2210 (Al phyllosilicate or hydrated glass)
blue = BD1900 (hydrated sulfates, clays, or glass)

CRISM CDP Continued

FRT 91C5 IR_PHY
regional stretch

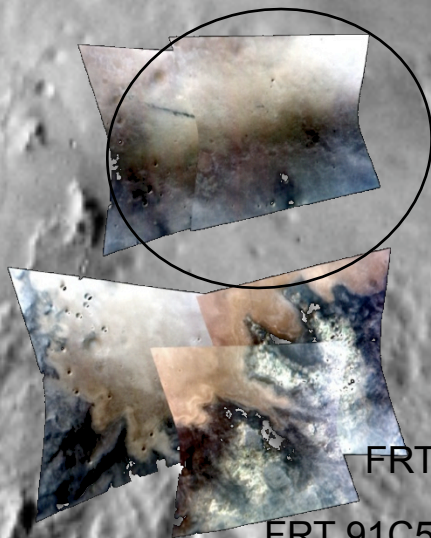


FRT 91C5 IR_PHY
image stretch



red = BD2300 (Fe/Mg phyllosilicate)
green = BD2210 (Al phyllosilicate or hydrated glass)
blue=BD1900 (hydrated sulfates, clays, or glass)

CRISM CDP IR_RGB



FRT A063

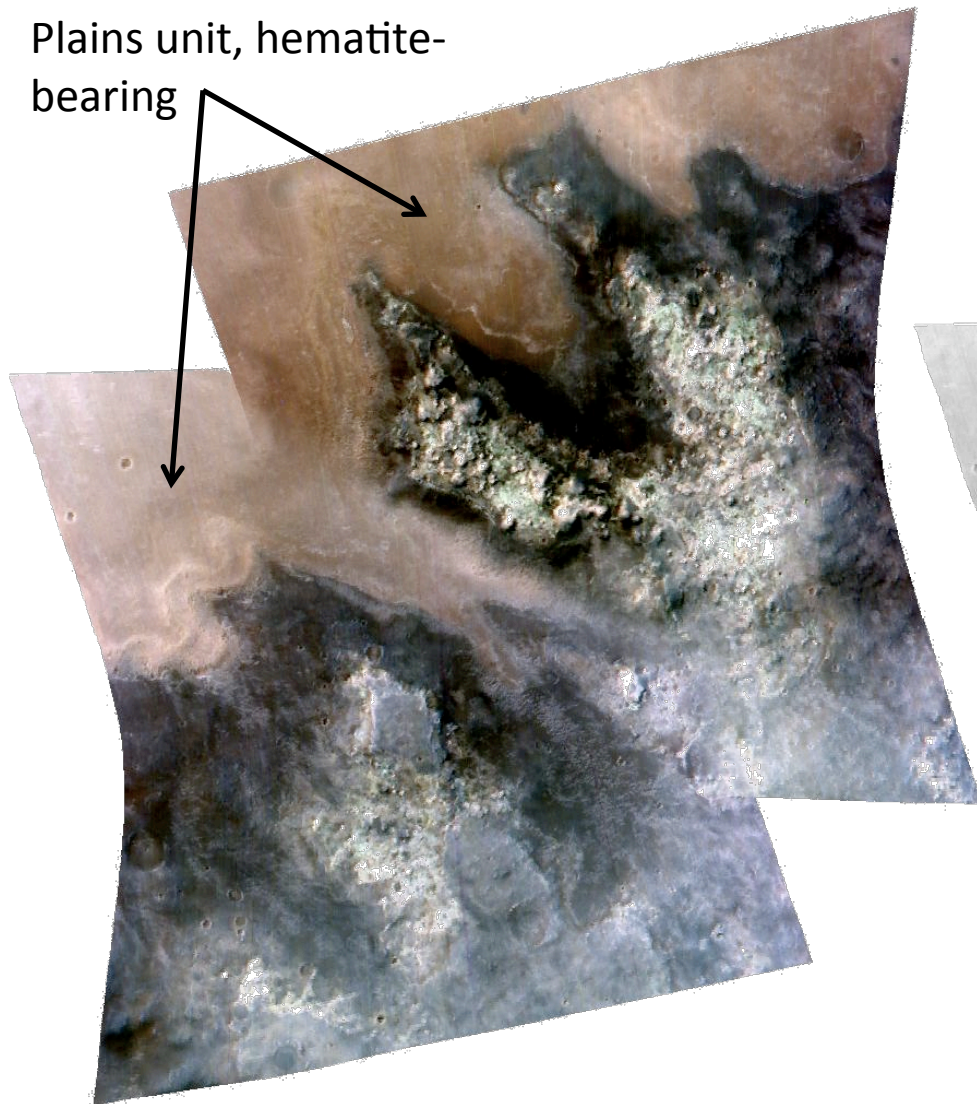
FRT 91C5

THEMIS DIR

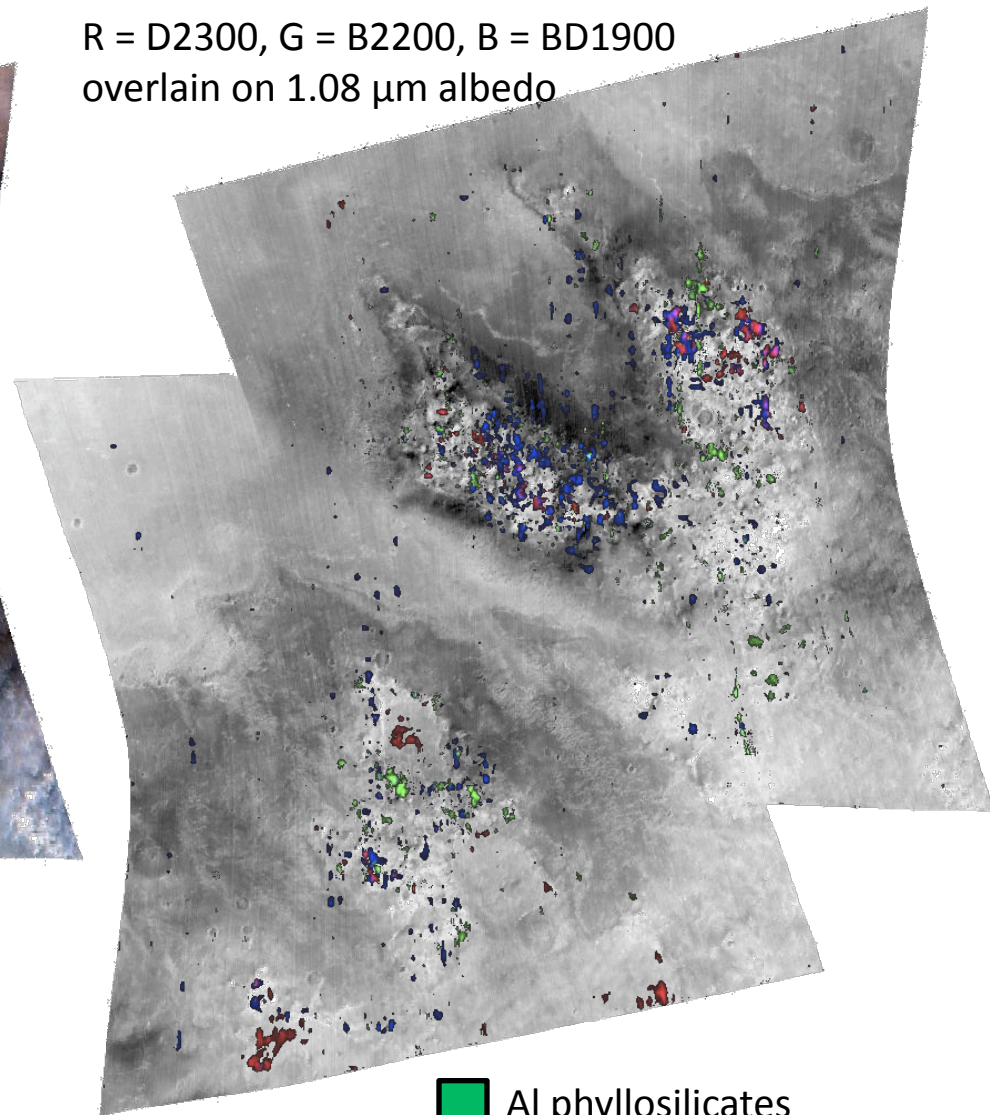
CRISM FRT 91C5 and FRT A063

R = D2300, G = B2200, B = BD1900
overlay on 1.08 μm albedo

Plains unit, hematite-bearing



False color composite:
R = 2.5, G = 1.5, B = 1.08 μm



- Al phyllosilicates
- Fe/Mg phyllosilicates
- Other hydrated phases

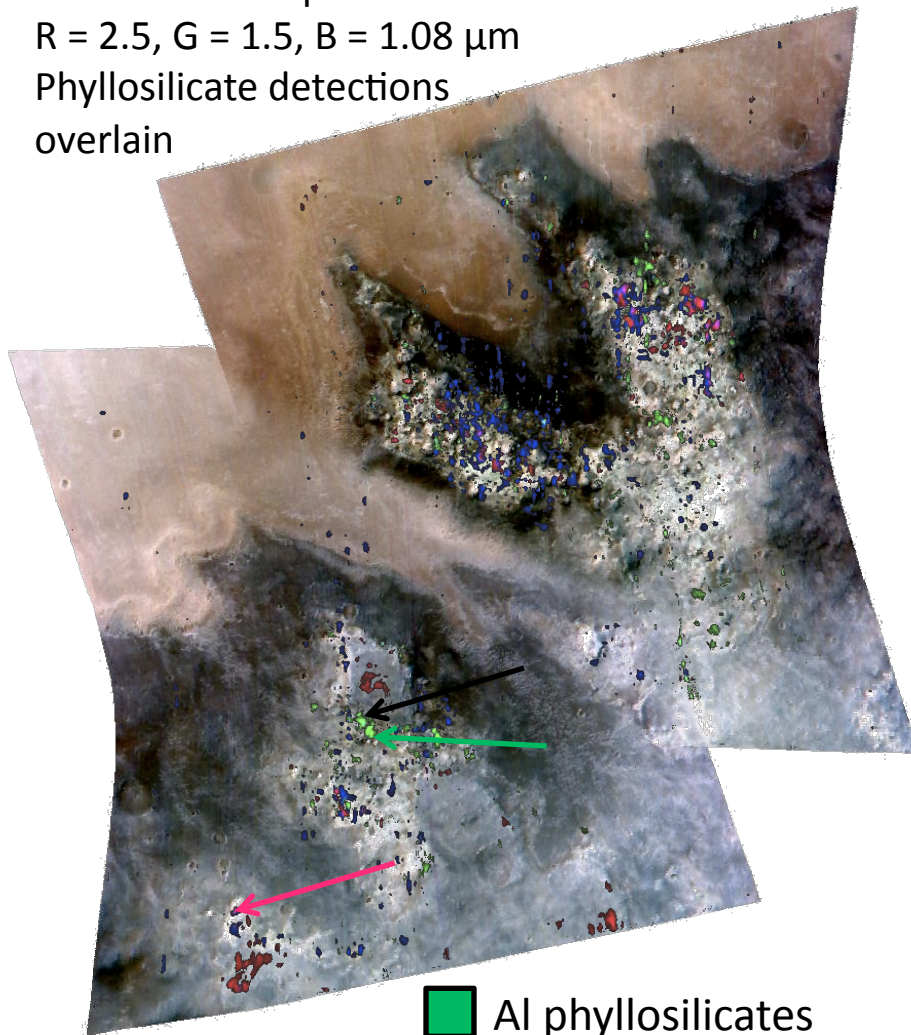
Phyllosilicate Diversity

CRISM FRT 91C5 and FRT A063

False color composite:

R = 2.5, G = 1.5, B = 1.08 μm

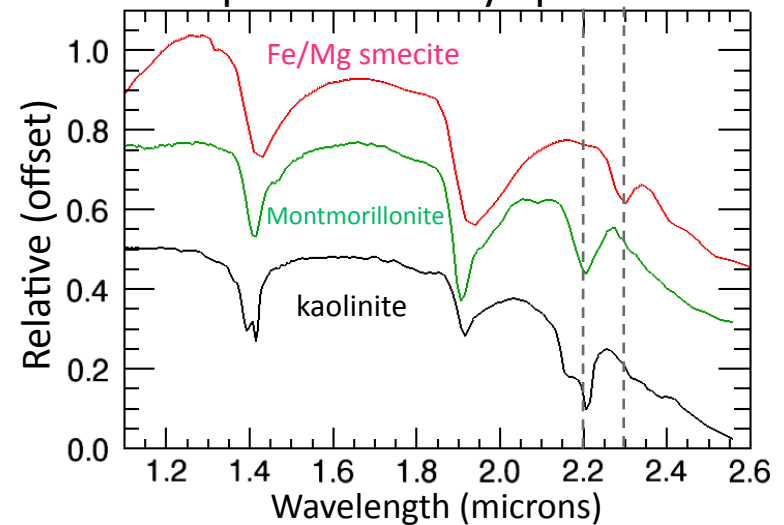
Phyllosilicate detections
overlay



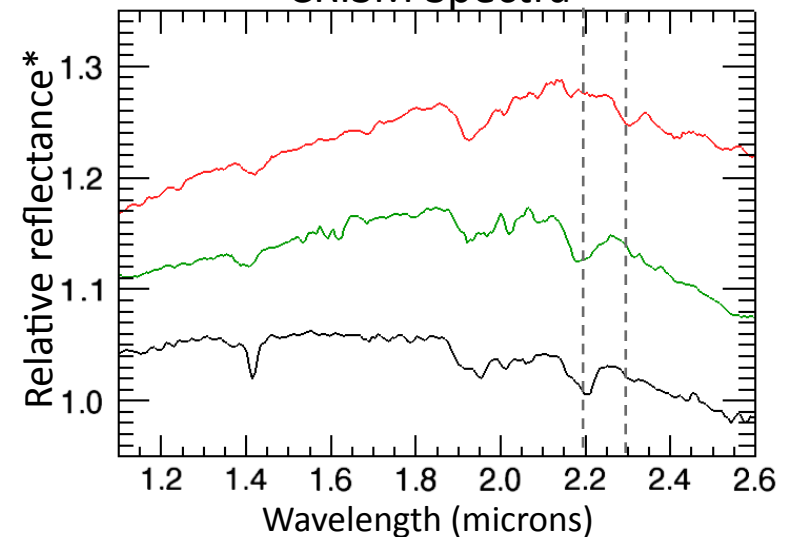
- Al phyllosilicates
- Fe/Mg phyllosilicates

Relative reflectance* = (CRISM I/F spectrum of interest) / (CRISM I/F 'bland' spectrum)

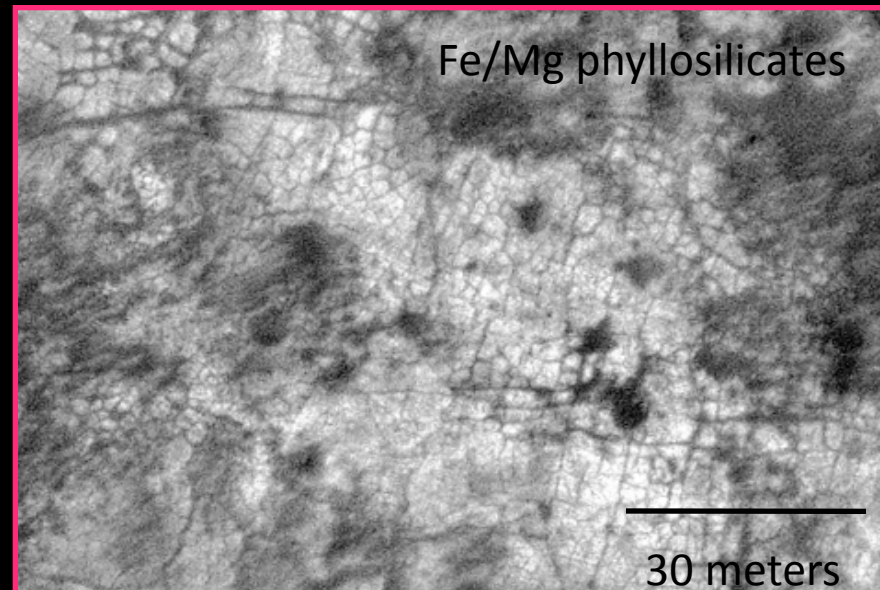
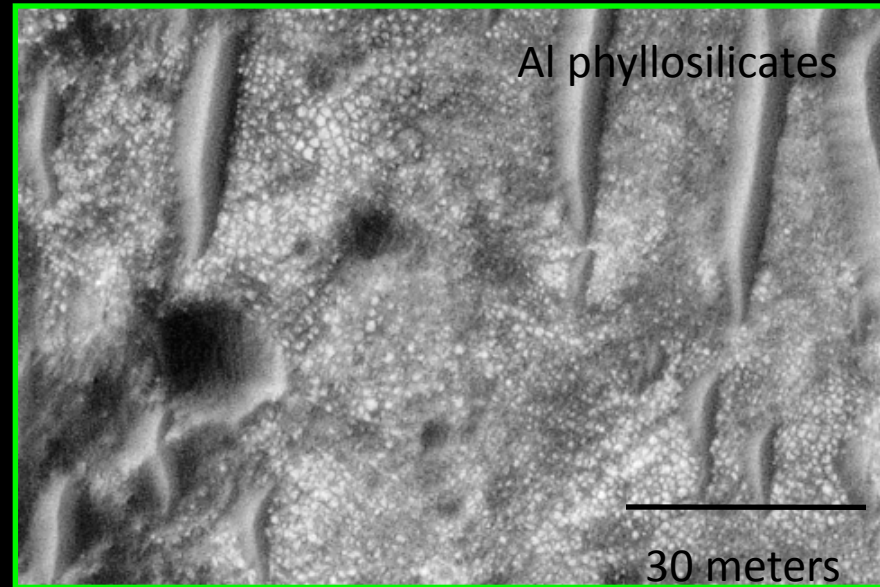
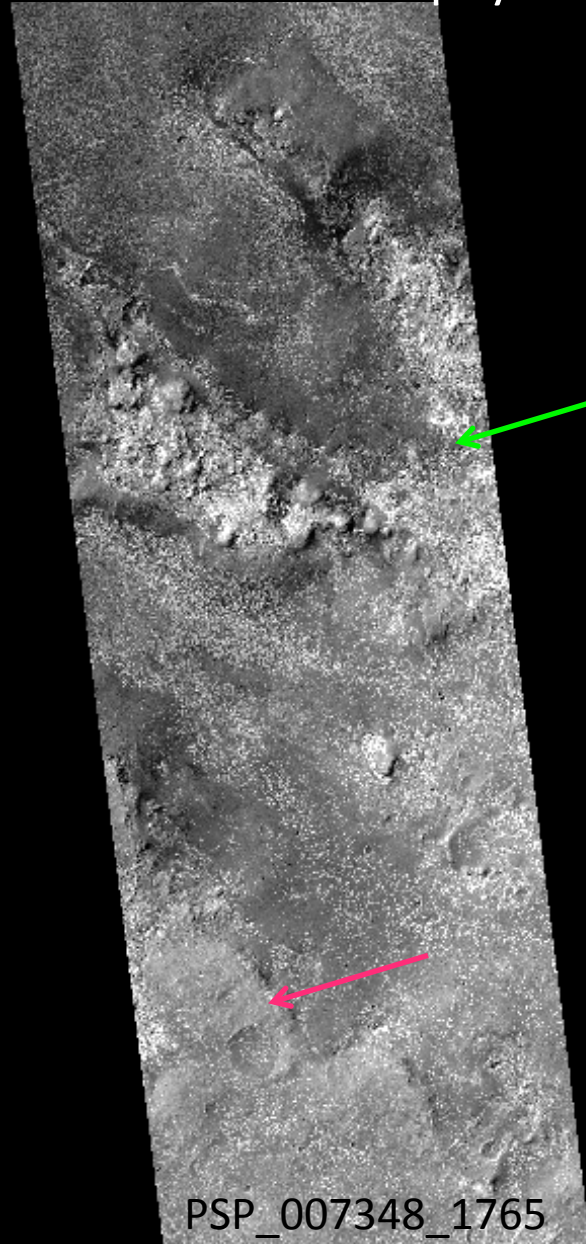
Spectral Library Spectra



CRISM Spectra



CRISM phyllosilicate spectral signatures correlate with polygonally fractured bedrock in HiRISE → phyllosilicates are 'in place.'



Geologic Context

- Older, phyllosilicate-bearing terrain cut by fluvial features
- Plains deposits embay

CRISM FRT A063 and 91C5

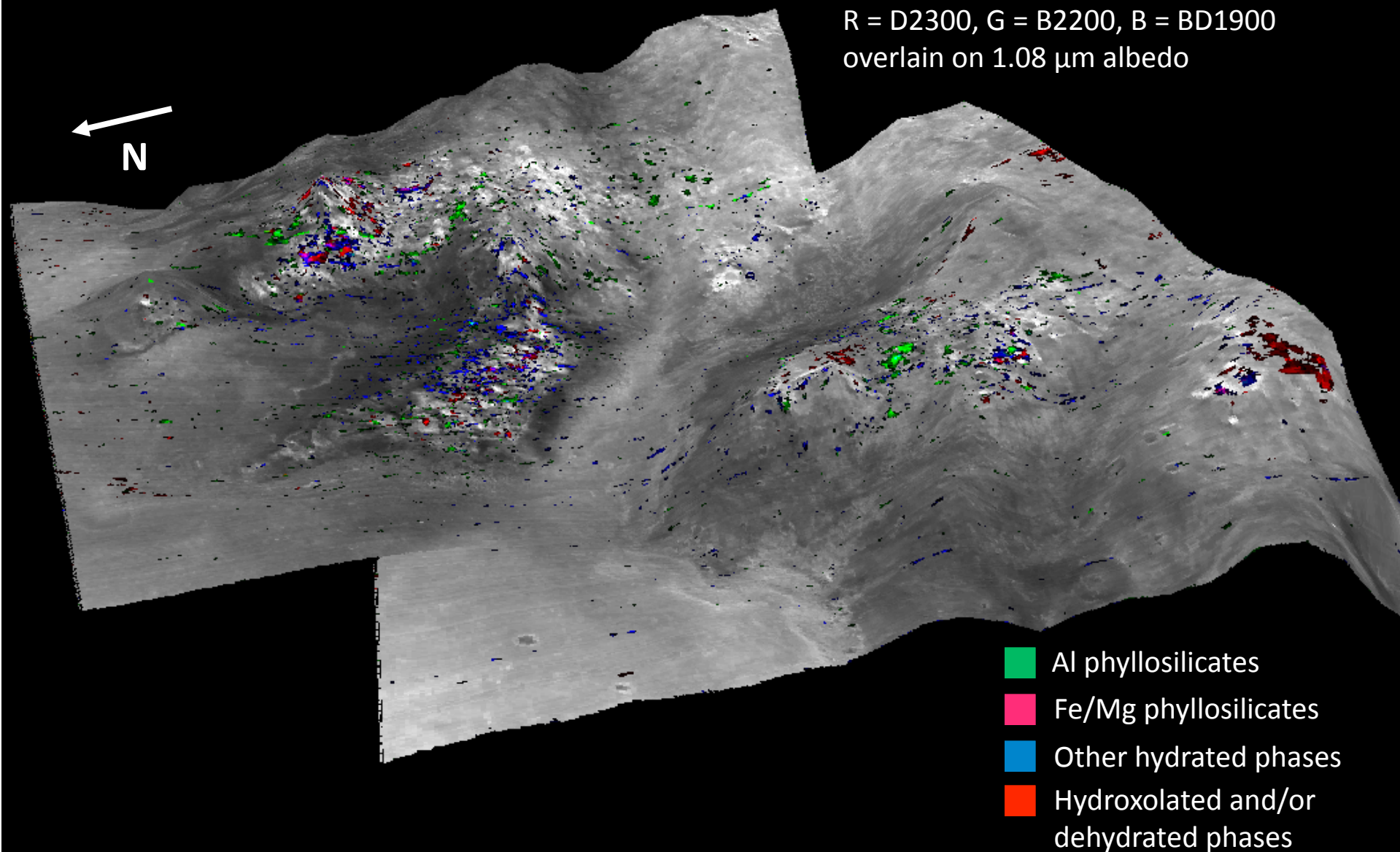
N



CTX P14_006702_1767
draped on MOLA topography
vertical exaggeration = 10

CRISM FRT 91C5 and A063
draped on MOLA topography
vertical exaggeration = 10

R = D2300, G = B2200, B = BD1900
overlain on 1.08 μm albedo



- Al phyllosilicates
- Fe/Mg phyllosilicates
- Other hydrated phases
- Hydroxylated and/or dehydrated phases

- Plains material embays phyllosilicate-bearing terrain
→ Phyllosilicates predate formation of plains unit explored by Opportunity rover ~75 km to the north

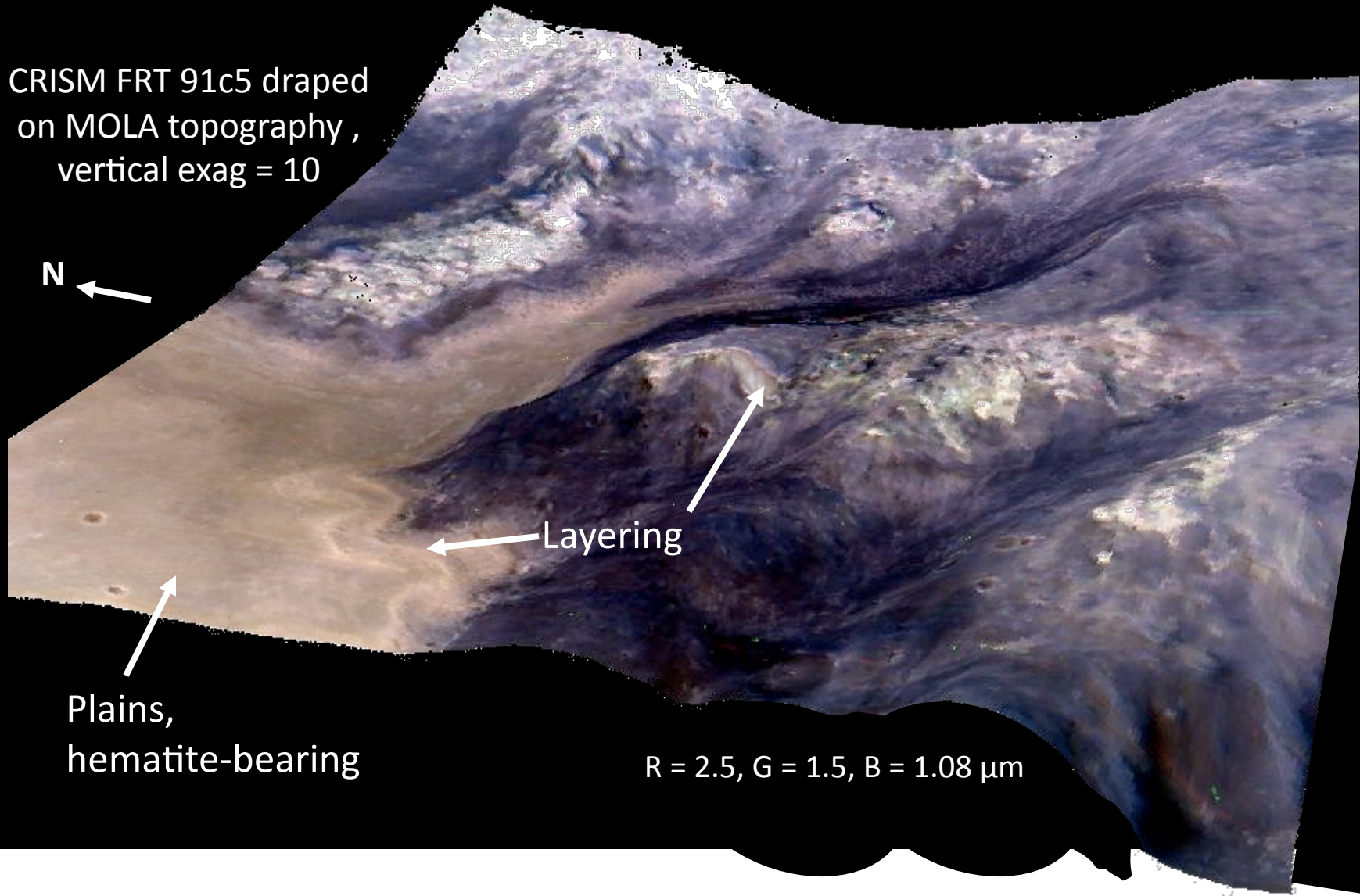
CRISM FRT 91c5 draped
on MOLA topography ,
vertical exag = 10

N

Layering

Plains,
hematite-bearing

R = 2.5, G = 1.5, B = 1.08 μm

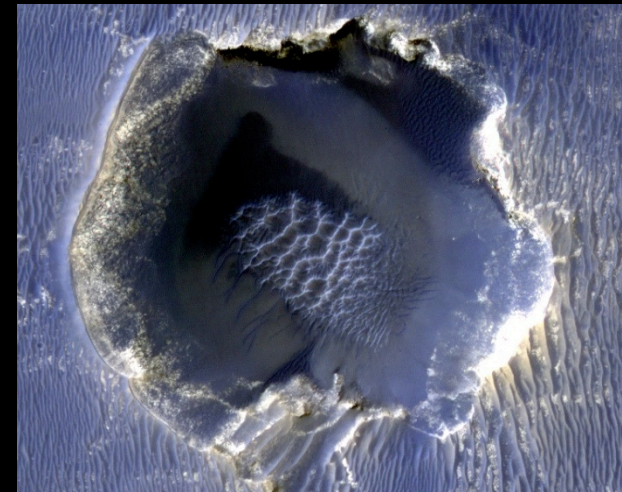


Discussion

- Good geologic context
 - Phyllosilicate alteration/deposition during the Noachian period
 - In place material
 - Unconformity: Period of fluvial erosion (middle to late Noachian)
 - Accumulation of sulfate-rich sediments (late Noachian / early Hesperian)
- Diversity : Two distinct geochemical environments accessible to rover (within ~10 km traverse from center)
 - Phyllosilicate alteration, likely in a an open hydrologic regime under moderate pH conditions with high water to rock ratio
 - Deposition of sulfate-rich evaporitic deposits in a ground water dominated regime, lower water to rock ratio
- Intact Noachian / Hesperian contact
 - Older, altered Noachian basement and younger sedimentary sulfate-rich deposits
 - Relative age relationship clear because phyllosilicate materials are fluvially dissected and embayed by sulfate and hematite plains

Phase I: Sedimentary Stratigraphy

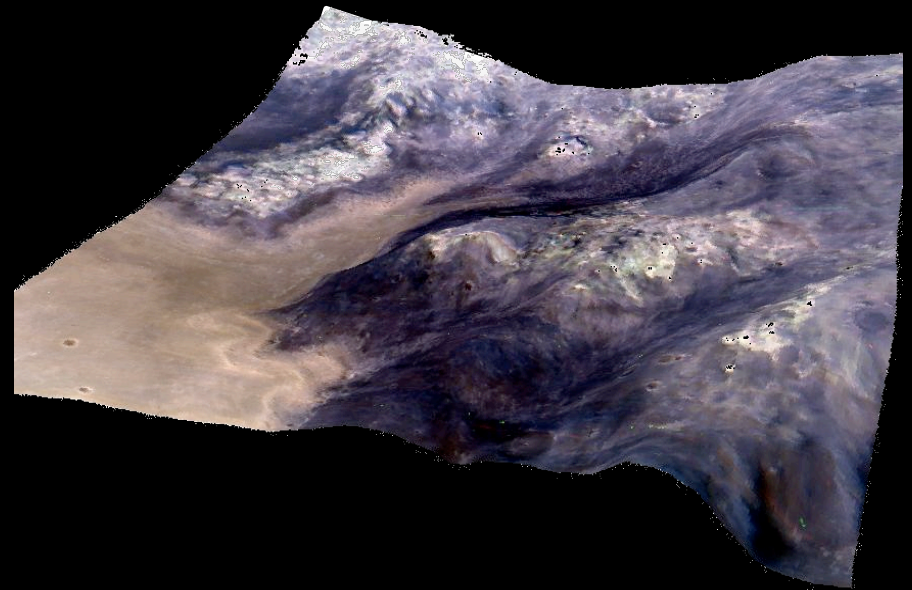
- Plains unit
 - Landing ellipse within sulfate and hematite plains unit explored by the MER Opportunity rover ~75 km to the north
 - Light-toned layered bedrock overlain by thin sand sheet
 - Hematite detections (TES) within ellipse, inferred to be sulfate-rich based on MER ground truth
- More basal strata exposed
 - Near unit margin
 - 75 km to south of Opportunity rover
 - 200 m lower in elevation (coupled with regional slope to the north, this is likely much lower in the stratigraphic section than the Burns formation)
 - Characterize with MSL assets
 - Synergy with MER
- Preservation potential
 - Depositional / evaporitic environment → Good
- Habitability
 - Water activity?



250 m in diameter crater
PSP_7348_1765 subset

Phase II: Noachian / Hesperian Contact

- Traverse south from landing site (10 km)
 - Characterize contact between sedimentary sulfate-rich deposits and Noachian basement
 - Distinct horizon??
 - Geochemical contact?
- Fluvial dissection
 - Geomorphic evidence for fluvial dissection
 - Overland flow of water
 - Channel related deposits?



Phase III: Noachian Phyllosilicates

- Mineral Diversity
 - Al-rich phyllosilicates – High water to rock ratio
 - Kaolinite
 - Montmorillonite
 - Fe / Mg smectite
- Compositional stratification
 - Detailed mapping with HiRISE and CRISM in progress
 - Is mineral diversity related to
 - Original composition?
 - Geochemical variations?
- Formation hypotheses to test
 - Inplace alteration of Noachian crust
 - Hydrothermal circulation?
 - Sedimentary deposits
 - Pedogenic process?
 - Impact related
- Preservation potential
 - Smectite clays → GOOD
 - Biomarkers, fossils
- Habitability
 - Geochemical conditions implied by phyllosilicates → GOOD

